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Chemical Compatibility of Avermectins and Chitin Synthesis Inhibitors with Common Fungicides against *Spodoptera litura*

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ABSTRACT

An experiment was conducted on the chemical compatibility of avermectins and chitin synthesis inhibitors with common fungicides against Spodoptera litura The LC_{50} of the insecticides viz., abamectin, emamectin benzoate, novaluron and lufenuron against S. litura was determined as 210.23, 102.12, 350.45 and 453.78 ppm, respectively, whereas the fungicides viz., mancozeb, chlorthalonil, and carbendazim recorded LC_{50} values of 97.0, 1.16 and 40.94 ppm respectively. The test fungicides were non toxic to S. litura. Of all the insecticide – fungicide combinations studied on the larval mortality of S. litura, the combination of emamectin benzoate with carbendazim at their LC_{50} values recorded maximum antagonism. Equivalism was observed in the combinations, abamectin with mancozeb, emamectin benzoate with chlorothalonil, lufenuron with mancozeb and lufenuron with chlorothalonil at their respective LC_{50} values. All other combinations showed varied degrees of synergism and antagonism.

Keywords: *Spodoptera litura*, Compatibility, Insecticides and Fungicides

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INTRODUCTION

Combined applications of insecticides and fungicides may result either in synergism or antagonism between them. Synergism is produced when the association of fungicides with insecticides leads to a joint action that is superior to the arithmetical sum of actions exercised by the single fungicide or insecticide. Antagonism is the condition found when the efficacy of the association is below the arithmetical sum of actions expressed by the single fungicide or insecticide. The combination of monocrotophos with mancozeb showed decreased insecticidal activity against red cotton bug (Lakshminarayana and Subbaratnam, 2000). When the pesticide mixture yields neither increased nor decreased effect to the arithmetical sum of actions expressed by them when used alone, such condition is said to be showing independent effect upon mixing.

Compatibility of insecticides with fungicides against Spodoptera litura

Avermectins are macrocyclic insecticides with low toxicity to non-target organisms and the environment. Chitin synthesis inhibitors are known to influence the insects by inhibiting or interfering with chitin deposition during and after moult and are referred as insect specific insecticides. They are recommended for use against wide spectrum of lepidopteron pests attacking the foliage and fruits. Therefore, it is felt essential to test these specific insecticides which are relatively safer to non target organisms and environment, and fit in integrated pest management IPM, for their efficacy when mixed with fungicides before recommending them in combination with any of the fungicides.

MATERIALS AND METHODS

Investigations were conducted during 2009-10 in the Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad. For evaluating the biological effectiveness of insecticides in combination with fungicides, tobacco caterpillar, *Spodoptera litura* was used as test insect.

S. litura larvae were collected from a field and was maintained in the laboratory. Third instar larvae of *S. litura* of same size and age were selected for bioassay experiments. For testing the toxicity of insecticides alone against larvae of *S. litura*, the larvae were exposed to insecticides by using micropipette. Wide range concentrations were selected for determining the LC_{50} values of insecticides. Based on that, narrow range concentrations were used with three replications having 10 larvae per replication. Observations on mortality were recorded at 24, 48 and 72 hrs intervals after the treatment.

Later, the LC_{50} of insecticides were mixed with different concentrations of fungicides which were selected based on the recommended dose for disease control in the field as the basis and 2 lower and 2 higher to the recommended dose. The larvae of *S. litura* were exposed to these mixtures in the same way as described earlier for insecticide alone. Synergism, antagonism and no effect was assessed in respect of toxicity of insecticide to test insect when mixed with fungicide.

Four insecticides, Abamectin (Dynamite, 1.9% EC) at 0.019%, Emamectin benzoate (Proclaim 5% SG) at 0.002%, Novaluron (Rimon 10% EC) at 0.01% and Lufenuron (Sigma 5.4% EC) at 0.01% and for fungicides, Mancozeb (Dithane M- 45) at 0.25%, Carbendazim (Bavistin 50% WP) at 0.10% and Chlorothalonil (Kavach 75%WP) at 0.20% were selected for the study.

Compatibility of insecticides with fungicides against *Spodoptera litura*
Spodoptera litura was exposed initially to a wider range of concentrations and mortality is recorded. A series of concentrations of narrow range were selected to which the test insect was again exposed. The same procedure was repeated till mortality is in a range of 20.0 to 80.0 per cent is obtained. The narrow range concentrations of selected insecticides which gave mortality in the above range are Abamectin(350, 300, 250, 200, 150, 100 and 50 ppm) Emamectin benzoate(180, 160, 140, 120, 100, 80 and 60 ppm), Novaluron(600, 500, 400, 300, 200 and100 ppm) and Lufenuron(900, 700, 500, 400, 300 and 200 ppm).

The data obtained in various experiments were statistically analyzed by using Completely Randomized Design (CRD) as per procedure suggested by Snedecor and Cochran (1967) and Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Effect of insecticides alone on the mortality of *S. litura*
From the table 1, it shows that the mortality of 89.99, 82.60, 77.33, 67.22, 43.00, 35.20 and 30.66 per cent was recorded at concentrations of 350, 300, 250, 200, 150, 100 and 50 ppm, respectively as against nil mortality in control. It is evident from the data that the mortality decreased steadily with the decrease in concentration of the insecticide. By subjecting the corrected mortality data to probit analysis (Finney, 1952), the LC_{50} value of abamectin against the test insect was found to be 210.23 ppm. The population of the test insect was homogenous as evidenced by heterogeneity test.

The mean of corrected mortality percentages recorded were 80.00, 73.33, 66.66, 60.00, 46.66 and 36.66 at 180, 160, 140, 120, 100 and 80 ppm concentrations of emamectin benzoate, respectively. From the data it was clear that there was a steady decrease in mortality of the test insect with decrease in concentration of the insecticide. The LC_{50} of emamectin benzoate against *S. litura* was found to be 102.12 ppm. At the concentrations of 600, 500, 400, 300, 200 and 100 ppm, the mortality of *S.litura* recorded was 77.35, 67.45, 52.63, 47.44, 30.32 and 24.12 per cent, respectively.

The mortality decreased progressively with the decrease in concentrations of insecticide. The LC_{50} value of the novaluron against *S.litura* was established to be 350.45 ppm. The chi-square test indicated that the *S.litura* larval population used in this study was homogeneous ($\chi^2 = 1.220$).

The per cent mortality of insect larvae recorded was 76.66, 63.33, 53.33, 46.66, 36.66 and 23.33 at 900, 700, 500, 400, 300 and 200 ppm concentrations of lufenuron, respectively. The mortality of the test insect

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in control was nil. There was gradual decrease in mortality with the decrease in concentration of the insecticide. The lethal concentration for affecting 50.0 per cent kill of the insect larvae (LC_{50}) was found to be 453.78 ppm. The populations of the test was homogenous as considered by heterogeneity test (χ^2 =0.762) (**Table 1**).

Effect of insecticides in combination with fungicides at their LC_{50} values on mortality of *S. litura*

From the table 2, the fungicides carbendazim and chlorothalonil enhanced the insecticidal activity of abamectin (LC_{50}) which resulted in increasing in mortality of *S. litura* larvae to 56.67 and 63.33 per cent respectively. However, mancozeb showed no change in the insecticidal activity of abamectin. Suggesting that all the three fungicides were compatible with abamectin at their LC_{50} concentrations, as there was no significant reduction in mortality of *S. litura* larvae compared to abamectin when used alone. Similar equivalism was observed by Undirwade *et al.* (1993) when maneb at 0.25 per cent was applied in combination with insecticides, dimethoate at 0.03 per cent (or) monocrotophos 0.06 per cent or cypermethrin at 0.0075 per cent against boll worm infestation on buds of cotton. However, abamectin 210.23 ppm in combination with carbendazim (40.94 ppm) and chlorothalonil (1.16 ppm) caused 56.67 and 63.33 per cent mortality with enhanced insecticidal activity significantly over abamectin LC_{50} alone exhibiting synergism.

Emamectin benzoate (102.12) ppm in combination with fungicide viz., chlorothalonil 1.16 ppm concentration recorded 53.33 per cent larval mortality, which was at par to the emamectin benzoate LC_{50} alone. The results showed that these fungicides exerted no effect on the insecticidal activity and also compatible with emamectin benzoate. The per cent corrected mortalities of emamectin benzoate in combination with carbendazim and chlorothalonil was higher than the per cent corrected mortality in emamectin benzoate 102.12 ppm (50.00%) at its LC_{50} value, indicating synergism and while emamectin benzoate with mancozeb showed 43.33 per cent mortality which was significantly less than emamectin benzoate alone at LC_{50}.

The fungicides *viz*, mancozeb (97.0 ppm), chlorothalonil (40.94 ppm), carbendazim (40.94 ppm) (LC_{50}) enhanced the insecticidal activity of novaluron 350.45 ppm when studied against *S. litura* larvae by recording 54.44, 62.66 and 64.44 per cent mortality exhibiting synergism. Similar results were documented by Krishnaiah and Reddy (1992) when IBP (0.048%) was combined with monocrotophos (0.05%) against BPH, with increased mortality.The combination of lufenuron (453.78 ppm) with carbendazim (40.94 ppm) recorded lower per cent corrected mortality values when compared with lufenuron alone, indicating antagonistic activity and the

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combination of lufenuron (453.78 ppm) + mancozeb (97.0 ppm) and lufenuron (453.78 ppm) + chlorothalonil (1.16 ppm) exhibited no effect. To corroborate these findings, information pertaining to the efficacy of abamectin in combination with fungicides is not available. However, earlier reports indicated the decreased efficacy of certain insecticides in combination with fungicides, and has been attributed to antagonism. (Sreedharan *et al.*, 1981 and Saini and Ramesh, 1982) (**Table 2**).

Effect of insecticides (LC_{50}) in combination with fungicides at different concentrations on mortality of *S. litura*

Abamectin (210.23 ppm) in combination with mancozeb at three concentrations resulted in increased mortality after 72 h of exposure. The per cent mortality of *S. litura* recorded by abamectin LC_{50} in combination with mancozeb was 56.67, 63.33 and 70.00 per cent each at 1875, 2500 and 3125 ppm. Thus, abamectin in combination with mancozeb was compatible and synergistic by recording high per cent mortality of *S. litura* at all test concentrations, which were significantly differ to that of abamectin LC_{50} alone. The results were in accordance with the reports of Ali and Singh (2003) who documented that synergistic action of endosulfan (0.07%) when combined with mancozeb (0.2%) by recording 20.80 and 15.35 per cent mortality of sesamum capsule borer and gall fly, respectively as against 11.73 and 10.00 per cent without mancozeb (0.2%). Similar, results of increased synergism with increase in concentration of mancozeb in combination with abamectin was reported by Dikshitulu and Subbaratnam (1996) in combination with permethrin at 2.1 ppm concentration (LC_{50}) against red cotton bug on cotton **(Table 3).**

Though carbendazim alone was non toxic to *S.litura*, in combination with abamectin 210.23 ppm (LC_{50}) the per cent mortality recorded was higher than abamectin LC_{50} alone. It showed that the synergistic interaction between these two components resulted in enhanced insecticidal activity which increased with the increase in concentration of carbendazim by recording minimum of 70.00 per cent and maximum of 83.33 per cent mortality at 750 and 1250 ppm concentrations in combination with abamectin (LC_{50}). The combination of abamectin 210.23 ppm (LC_{50}) with carbendazim 1250 ppm was significantly superior over the two treatment combinations which were at par to each other. Undirwade *et al.* (1993) reported the synergistic nature of monocrotophos (0.06%) in combination with carbendazim (0.1%) with reduced per cent incidence of boll worm on buds of cotton plants. Abamectin 210.23 ppm (LC_{50}) recorded no change in the insecticidal activity when

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combined with chlorothalonil at 1875 ppm concentration by recording 46.66 per cent mortality of *S.litura* which was on par to abamectin LC_{50} alone, exhibiting equivalism. However, in combination with chlorothalonil at 2500 and

3125 ppm, abamectin 210.23 ppm (LC_{50}) recorded less mortality of 40.00 and 33.33 per cent larvae of *S.litura*, respectively. This indicated that the interaction leads to antagonism by reduced insecticidal activity of abamectin. The combination of non-systemic affect of insecticide fungicide Karathane (0.1%) did not affect the insecticidal activity of abamectin (0.07%) showing equivalism (Shukla and Lal, 1989) when tested on pea pod borer **(Table 3)**.

Emamectin benzoate 102.12 ppm showed antagonism with mancozeb at varied concentrations against *S. litura*. A minimum of 26.66 and maximum of 36.67 per cent larval mortality was recorded by emamectin benzoate in combination with mancozeb at 3125 and 1875 ppm, respectively. The data clearly indicates antagonistic nature of mancozeb to emamectin benzoate which increased with increase in concentration and the components were incompatible.

The information pertaining to the toxicity of emamectin benzoate in combination with fungicides is not available. However, previous reports indicated that the antagonistic nature of fungicides when mixed with insecticides was increased with increase in components and showed incompatibility when tested against brown plant hopper (Prakash and Srivastava, 1992). The insecticidal activity of (102.12 ppm) increased when mixed with carbendazim at various concentrations (750, 1000 and 1250 ppm) against *S. litura.* The components were compatible and enhanced the insecticidal property of emamectin benzoate.

Chlorothalonil at different concentrations when combined with emamectin benzoate 102.12 ppm showed compatibility without negatively affecting the insecticidal activity against *S.litura*. The mortality recorded was at par in combinations containing lower concentrations of chlorothalonil (1875 and 2500 ppm) and emamectin benzoate when used alone. Documented information is not available **(Table 4)**.

Mancozeb enhanced the insecticidal activity of novaluron 350.45 ppm (LC_{50}) in varied degree at different concentrations. Novaluron showed enhanced mortality of *S. litura* larvae which was minimum of 60 per cent and maximum of 63.33 per cent in combination with mancozeb at 1875 and 3125 ppm concentrations, respectively. The combination of novaluron with mancozeb at 2500 and 3125 ppm was statistically superior than novaluron tested alone. However, the present results vary with that of Dikshitulu (1985) who reported that

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certain insecticide – fungicidal combinations resulted in synergism but it decreased with increased concentration of carbendazim.

Novaluron 350.45 ppm (LC_{50}) showed antagonistic effect upon mixing with carbendazim at concentrations of 1000 and 1250 ppm by recording 40.0 and 40.0 per cent mortality of *S. litura* larvae, respectively. While lowest concentration of 750 ppm with novaluron neither increased nor decreased the mortality. To corroborate these findings, information pertaining to efficacy of novaluron with carbendazim is not available. However earlier reports indicated that there was antagonism at lower concentrations and synergism at higher concentrations (Savitri *et al.*, 1998). The fungicide chlorothalonil was compatible and exhibited equivalism with novaluron 350.45 ppm (LC_{50}) at 1875 ppm *S. litura*. The per cent mortality recorded was 50.00 **(Table 5)**.

Mancozeb at concentrations of 1825, 2500 and 3125 ppm did not alter the insecticidal activity of lufenuron 453.78 ppm when tested against *S. litura*. The per cent mortality recorded were 50.0, 50.0 and 53.33, respectively with the above concentrations indicating independent effects of the components even when combined together. Savitri *et al.* (1998) assessed the efficacy of carbofuran (2 g/kg) in combination with mancozeb (3.0 g/kg) by applying them as seed treatment to stored groundnut against stored pest *Corcyra cepholonica* and seed borne fungi and reported that the combination did not affect the activity of individual components by recording similar larval mortality of test insect.

Lufenuron 453.78 ppm LC_{50} showed enhanced insecticidal activity in varied degrees when combined with carbendazim at different concentrations. The per cent mortality data indicated that the interaction resulted in synergism by recording higher mortality to a maximum of 70.00 and a minimum of 63.33 per cent. However, no enhanced effectiveness recorded when combined at lower concentration (750 ppm) of carbendazim. Manohar (2005) reported that chlorothalonil at 3125 ppm concentration resulted in maximum enhancement of insecticidal activity of lufenuron 353.78 ppm (LC_{50}) when it recorded 73.33 per cent mortality of *S. litura*. Lufenuron (453.78 ppm) recorded significantly higher per cent mortality of *S. litura* in combination with chlorothalonil at 2500 and 3125 ppm concentrations i.e. 53.33 and 56.66 per cent respectively as against 50 per cent when lufenuron LC_{50} with all concentrations and exhibiting good compatibility with synergism. However, at 1875 ppm of chlorothalonil, there was no variation in toxicity of lufenuron **(Table 6)**.

Table 1: Effect of insecticides on the mortality of *Spodoptera litura*

S.No.	Concentrations of Insecticides (ppm)	Mean mortality over control (%)	Heterogeneity	Regression equation	LC_{50} (Fiducial limits)
Abamectin					
1	350	89.99	χ^2 = 0.773	Y=1.8510+ 0.37X	210.23 (79.591-228.267)
2	300	82.60			
3	250	77.33			
4	200	67.22			
5	150	43.00			
6	100	35.20			
7	50	30.66			
Emamectin benzoate					
1	180	80.00	χ^2= 1.672	Y= -4.90+ 1.151X	102.12 (67.877-94.783)
2	160	73.33			
3	140	66.66			
4	120	60.00			
5	100	46.66			
6	80	36.66			
Novaluron					
1	600	77.35	χ^2=1.220	Y=0.07702+ 0.42873X	350.45 (301.2573-491.2354)
2	500	67.45			
3	400	52.63			
4	300	47.44			
5	200	30.32			
6	100	24.12			
Lufenuron					
1	900	76.66	χ^2=0.762	Y= -6.44+1.05X	453.78 (374.716-532.792)
2	700	63.33			
3	500	53.33			
4	400	46.66			
5	300	36.66			
6	200	23.33			
Control		0.0			

Table 2: Effect of insecticides in combination with selected fungicides at their LC_{50} values on mortality of *S. Litura*

Treatment. No.	Treatments (Concentration in ppm)	Corrected mortality at 72 h after treatment(%)
Abamectin		
1	Abamectin 210.23 ppm + mancozeb 97.0 ppm	50.00 (45.00)^c
2	Abamectin 210.23 ppm + carbendazim 40.94ppm	56.67 (48.84)^b
3	Abamectin 210.23 ppm + chlorothalonil 1.16 ppm	63.33 (52.77)^a
4	Abamectin 210.23 ppm (LC_{50})	50.00 (45.00)^c
	S.Em±	1.665
	C.D. (0.05%)	3.309
Emamectin benzoate		
1	Emamectin benzoate 102.12 ppm+ mancozeb 97.00 ppm	43.33 (41.15)^d
2	Emamectin benzoate 102.12 ppm + carbendazim 40.94ppm	66.66 (54.44)^a
3	Emamectin benzoate 102 12 ppm +chlorothalonil 1.16 ppm	53.33 (47.00)^b
4	Emamectin benzoate 102.12ppm (LC_{50})	50.00 (45.00)^c
	S.Em±	1.44
	C.D. (0.05%)	3.37
Novaluron		
1	Novaluron 350.45 ppm + mancozeb 97.0 ppm	54.44 (49.85)^c
2	Novaluron 350.45 ppm + carbendazim 40.94ppm	62.66 (55.08)^b
3	Novaluron 350.45 ppm+ chlorothalonil 1.16 ppm	64.44 (56.91)^a
4	Novaluron 350.45 ppm (LC_{50})	50.00 (45.00)^d
	S.Em±	0.74
	C.D. (0.05%)	1.88
Lufenuron		
1	Lufenuron 453.78 ppm + +mancozeb 97.0 ppm	50.00(45.00)^a
2	Lufenuron 453.78 ppm + carbendazim 40.94ppm	36.66 (36.00)^b
3	Lufenuron 453.78 ppm + chlorothalonil 1.16 ppm	50.00 (45.00)^a
4	Lufenuron 453.78 ppm (LC_{50})	50.00 (45.00)^a
	S.Em±	1.33
	C.D. (0.05%)	3.36

Figures in parentheses are angular transformed values
Figures indicated by same letters are not significantly different from one another as per DMRT
C.D. (0.05%): critical difference at 5 per cent level
SEm±: Standard Error of Mean

Table 3: Effect of abamectin (LC_{50}) in combination with different concentrations of mancozeb against *S. Litura*

Treatment. No.	Treatments (Concentration in ppm)	Corrected mortality at 72 h after treatment (%)
Abamectin + mancozeb		
1	Abamectin 210.23 ppm+ mancozeb 1875 ppm	56.67 (49.22)[c]
2	Abamectin 210.23 ppm + mancozeb 2500 ppm	63.33 (62.42)[b]
3	Abamectin 210.23 ppm + mancozeb 3125 ppm	70.00 (64.20)[a]
4	Abamectin 210.23 ppm (LC_{50})	50.00 (45.00)[d]
	S.Em±	1.22
	C.D. (0.05%)	2.22
Abamectin + carbendazim		
1	Abamectin 210.23 ppm+ carbendazim 750 ppm	70.00 (56.91)[c]
2	Abamectin 210.23 ppm+ carbendazim 1000 ppm	73.33 (59.00)[b]
3	Abamectin 210.23 ppm+ carbendazim 1250 ppm	83.33 (77.49)[a]
4	Abamectin 210.23 ppm (LC_{50})	50.00 (45.00)[d]
	S.Em±	0.78
	C.D. (0.05%)	1.87
Abamectin +chlorothalonil		
1	Abamectin 210.23 ppm+chlorothalonil 1875 ppm	46.66 (42.91)[b]
2	Abamectin 210.23 ppm+chlorothalonil 2500 ppm	40.00 (38.74)[c]
3	Abamectin 210.23 ppm+chlorothalonil 3125 ppm	33.33 (30.93)[d]
4	Abamectin 210.23 ppm+ (LC_{50})	50.00(45.00)[a]
	S.Em±	1.79
	C.D. (0.05%)	2. 62

Figures in parentheses are angular transformed values
Figures indicated by same letters are not significantly different from one another as per DMRT
C.D.(0.05%): critical difference at 5 per cent level
SEm± : Standard Error of Mean

Table 4: Effect of emamectin benzoate (LC_{50}) in combination with different concentrations of mancozeb against *S. Litura*

Treatment. No.	Treatments (Concentration in ppm)	Corrected mortality at 72 h after treatment (%)
Emamectin benzoate + mancozeb		
1	Emamectin benzoate 102.12 ppm+ mancozeb 1875 ppm	36.67 (37.22)[b]
2	Emamectin benzoate 102.12 ppm+mancozeb 2500 ppm	30.00 (33.00)[c]
3	Emamectin benzoate 102.12 ppm+mancozeb 3125 ppm	26.66 (23.88)[d]
4	Emamectin benzoate 102.12 ppm (LC_{50})	50.00 (45.00)[a]
	S.Em±	0.71
	C.D. (0.05%)	2.04
Emamectin benzoate + carbendazim		
1	Emamectin benzoate 102.12 ppm+ carbendazim 750 ppm	46.66 (46.22)[c]
2	Emamectin benzoate 102.12 ppm+carbendazim 1000 ppm	50.00 (47.77)[b]
3	Emamectin benzoate 102.12 ppm+carbendazim 1250 ppm	56.66 (57.49)[a]
4	Emamectin benzoate 102.12 ppm (LC_{50})	50.00 (45.00)[d]
	S.Em±	0.57
	C.D. (0.05%)	1.01
Emamectin benzoate +chlorothalonil		
1	Emamectin benzoate 102.12 ppm + chlorothalonil 1875 ppm	45.55 (43.22)[d]
2	Emamectin benzoate 102.12 ppm + chlorothalonil 2500 ppm	53.33 (51.42)[b]
3	Emamectin benzoate 102.12 ppm + chlorothalonil 3125 ppm	56.66 (54.44)[a]
4	Emamectin benzoate 102.12 ppm (LC_{50})	50.00 (45.00)[c]
	S.Em±	1.41
	C.D. (0.05%)	2.38

Figures in parentheses are angular transformed values
Figures indicated by same letters are not significantly different from one another as per DMRT
C.D.(0.05%): critical difference at 5 per cent level
SEm± : Standard Error of Mean

Table 5: Effect of novaluron (LC_{50}) in combination with different concentrations of mancozeb against *S. Litura*

Treatment. No.	Treatments (Concentration in ppm)	Corrected mortality at 72 h after treatment (%)
Novaluron + mancozeb		
1	Novaluron 350.45 ppm +mancozeb 1875 ppm	60.00 (46.91)[c]
2	Novaluron 350.45 ppm +mancozeb 2500 ppm	60.00 (51.42)[b]
3	Novaluron 350 45 ppm +mancozeb 3125 ppm	63.33 (58.20)[a]
4	Novaluron 350.45 ppm (LC_{50})	50.00 (45.00)[d]
	S.Em±	1.56
	C.D. (0.05%)	3.02
Novaluron + carbendazim		
1	Novaluron 350.45 ppm + carbendazim 750 ppm	43.33 (42.22)[b]
2	Novaluron 350.45 ppm + carbendazim1000 ppm	40.00 (38 22)[c]
3	Novaluron 350.45 ppm +carbendazim1250 ppm	40.00 (35.35)[d]
4	Novaluron 350.45 ppm (LC_{50})	50.00 (45.00)[a]
	S.Em±	1.58
	C.D. (0.05%)	3.07
Novaluron +chlorothalonil		
1	Novaluron 350.45 ppm + chlorothalonil 1875 ppm	50.00 (46.91)[c]
2	Novaluron 350.45 ppm + chlorothalonil 2500 ppm	56.66 (52.74)[a]
3	Novaluron 350.45 ppm + chlorothalonil 3125 ppm	56.66 (52.22)[b]
4	Novaluron 350.45 ppm (LC_{50})	50.00 (45.00)[c]
	S.Em±	1.45
	C.D. (0.05%)	3.11

Figures in parentheses are angular transformed values Figures indicated by same letters are not significantly different from one another as per DMRT
C.D.(0.05%): critical difference at 5 per cent level
SEm± : Standard Error of Mean

Table 6: Effect of lufenuron (LC_{50}) in combination with different concentrations of mancozeb against *S. Litura*

Treatment. No.	Treatments (Concentration in ppm)	Corrected mortality at 72 h after treatment (%)
Lufenuron + mancozeb		
1	Lufenuron 453.78 ppm + mancozeb 1875 ppm	50.00 (45.63)[c]
2	Lufenuron 453.78 ppm + mancozeb 2500 ppm	50.00 (47.42)[b]
3	Lufenuron 453.78 ppm + mancozeb 3125 ppm	53.33 (48.66)[a]
4	Lufenuron 453.78 ppm (LC_{50})	50.00 (45.00)[d]
	S.Em±	1.56
	C.D. (0.05%)	3.09
Lufenuron + carbendazim		
1	Lufenuron 453.78 ppm + carbendazim 750 ppm	53.33 (46.27)[c]
2	Lufenuron 453.78 ppm + carbendazim 1000 ppm	63.33 (50.77)[a]
3	Lufenuron 453.78 ppm + carbendazim 1250 ppm	70.00 (57.49)[b]
4	Lufenuron 453.78 ppm (LC_{50})	50.00 (45.00)[d]
	S.Em±	1.75
	C.D. (0.05%)	3.06
Lufenuron +chlorothalonil		
1	Lufenuron 453.78 ppm+chlorothalonil 1875 ppm	53.33 (48.63)[c]
2	Lufenuron 453.78 ppm+chlorothalonil 2500 ppm	53.33 (51.42)[b]
3	Lufenuron 453.78 ppm+chlorothalonil 3125 ppm	56.66 (57.49)[a]
4	Lufenuron 453.78 ppm (LC_{50})	50.00 (45.00)[d]
	S.Em±	1.35
	C.D. (0.05%)	3.62

Figures in parentheses are angular transformed values Figures indicated by same letters are not significantly different from one another as per DMRT
C.D.(0.05%): critical difference at 5 per cent level
SEm± : Standard Error of Mean

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